

CLASSICAL BIOLOGICAL CONTROL OF THE ALFALFA WEEVIL IN JAPAN

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ABSTRACT

The alfalfa weevil was accidentally introduced into Japan in early 1980's and has been heavily infesting the Chinese milk vetch in paddy fields ever since. Chinese milk vetch is main source of honey products for apiarists in spring. Thus, the alfalfa weevil is not a pasture pest but a pest of apiculture. Four species of parasitoids were introduced into Japan as biological control agents for this pest from U.S.A. in 1988 and 1989. One of the parasitoids, *Bathyplectes anurus* was recovered in 1997. The percentage parasitism by *B. anurus* is higher on Narrow-leaved vetch in surrounding grasslands than on the Chinese milk vetch in paddy fields, suggesting that the conservation of these grasslands is important for the biological control of the alfalfa weevil.

INTRODUCTION

The alfalfa weevil, *Hypera postica* (Gyllenhal) (Coleoptera: Curculionidae) is the most serious pest of alfalfa in the United States (USDA 1991). This pest is of Eurasian origin and was accidentally introduced into North America. Classical biological control of this pasture pest has a had almost 100 years of history in the U.S.A. and this has been summarized by Radcliffe *et al.* (1998). In all, 12 species of natural enemies were involved in the combined USDA biological control program against the alfalfa weevil (Bryan *et al.* 1993). In most major American alfalfa production areas, several natural enemies of the alfalfa weevil are now well established and alfalfa growers benefit from their effects (Radcliffe *et al.* 1998).

The alfalfa weevil was also accidentally introduced into Japan during the early 1980's (Okumura 2002), however, its impact on alfalfa has thus far been limited because it has yet to reach the commercial alfalfa production areas located near Hokkaido. The crop heavily in-

festated by the weevil is Chinese milk vetch (*Astragalus sinicus* L.), grown in paddy fields during the early spring. Japanese rice farmers keep Chinese milk vetch as green manure in winter and the flowers of the plant provide the main source of honey products for apiarists during spring. Thus, the alfalfa weevil is not a pasture pest but more a pest of the paddy field agro-ecosystem during the non-crop season in Japan.

Moji Plant Protection Station introduced four species of parasitoids from U.S.A. into Japan for the biological control of this pest, (Kimura and Kaku 1991). One of the parasitoids, *Bathyplectes anurus* (Thomson) (Hymenoptera: Ichneumonidae) was recently recovered and is expanding its distribution. In this paper, we summarize the invasion biology of the alfalfa weevil in Japan and efforts towards its classical biological control. We also discuss the importance of natural enemy conservation and the future prospects of biological control of the alfalfa weevil.

INVASION BIOLOGY OF THE ALFALFA WEEVIL IN JAPAN

The alfalfa weevil was first discovered near Fukuoka airport in 1982 (Kimura *et al.* 1988). Subsequent surveys in the same year revealed that it was present in an area close to Fukuoka airport and widely distributed in Okinawa Island (Fig. 1). After that, the alfalfa weevil expanded its distribution towards eastern and northern Japan and has now reached Tokyo. The alfalfa weevil infests leguminous plants such as *Astragalus sinicus* (Chinese milk vetch), *Medicago lupulina* (black medick), *M. hispida* (burr medic), *M. sativa* (alfalfa), *Melilotus officinalis* (yellow sweet clover), *Trifolium pratense* (red clover), *T. repens* (white clover), and *Vicia sativa* (narrow-leaved vetch) in Japan (Yoshida *et al.* 1987). All of these leguminous plants in Japan are wild except alfalfa in Hokkaido, a northern island of Japan, and Chinese milk vetch in paddy fields of south and western Japan.

The larvae of the alfalfa weevil infest and seriously damage Chinese milk vetch flower buds and flowers in early spring. The production of honey from this source is greatly decreased as a consequence. When the farmers begin to flood the fields in May, the new adult weevils are forced to emigrate from paddy fields to aestivate following their emergence. These flooding events also displace natural enemies. After harvesting rice in the autumn, farmers seed with Chinese milk vetch to fertilize the fallow paddy fields and adult weevils are able to return to the fields. Adult female weevils oviposit on alfalfa during the winter and early spring, and larvae hatch and start damaging alfalfa from February to May.

INTRODUCTION EFFORTS OF NATURAL ENEMIES

Some indigenous parasitoids attack the alfalfa weevil but the percentage parasitism is very low and ineffective in suppressing populations of the alfalfa weevil (Okumura 1987). In order to conserve the paddy field agro-ecosystem during winter and spring, four species of parasitoids, *Bathyplectes anurus*, *B. curculionis* (Thomson), *Microctonus aethioides* Loan (Hymenoptera: Braconidae) and *M. colesi* Drea, were introduced as biological control agents of the alfalfa weevil from U.S.A. into Japan during 1988 and 1989 (Kimura and Kaku 1991).

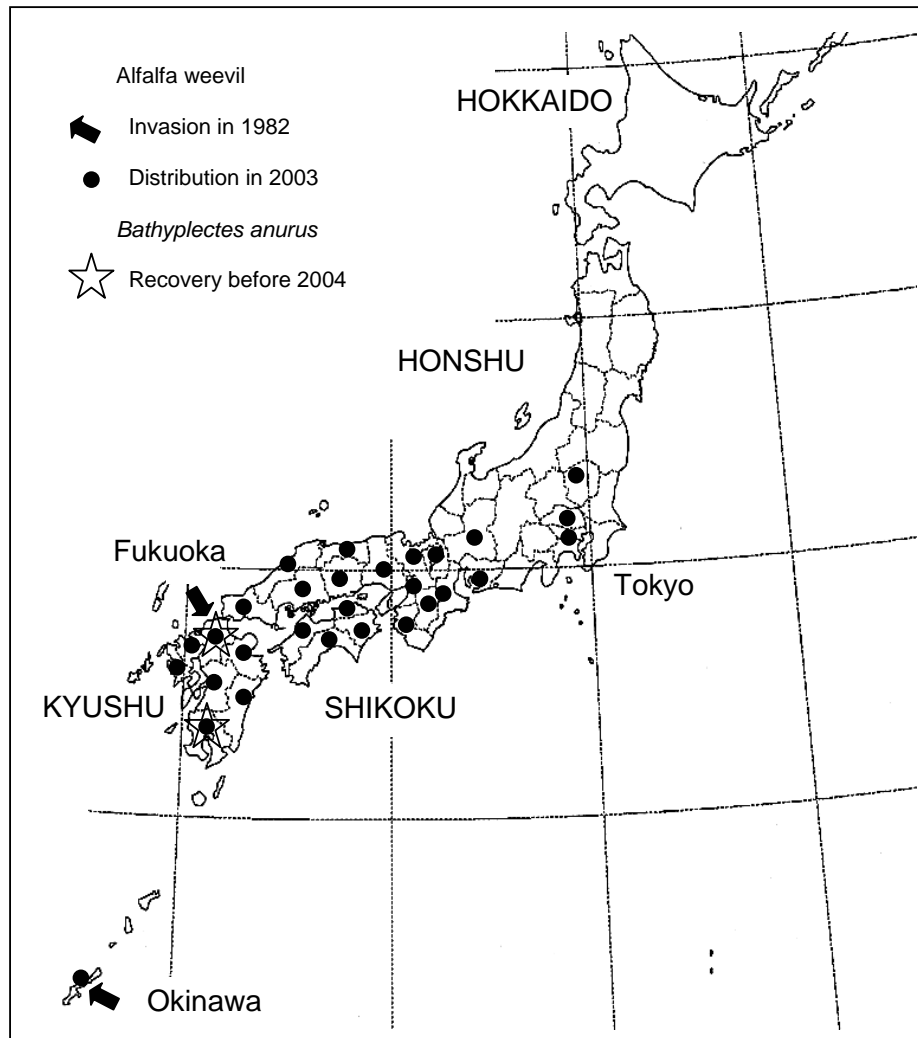


Figure 1. Invasion and geographic spread of the alfalfa weevil, *Hypera postica*, and recovery of its parasitoid, *Bathyplectes anurus* in Japan.

These parasitoids, except for *M. colesi*, were repeatedly released mainly in Kyushu after mass production in the laboratory. Despite these efforts, no parasitoids were considered established until 1996 (Okumura *et al.* 2002). One of the reasons for failure is that rice fields are tilled and irrigated before they are planted in the growing season. Because of these agricultural practices, both the alfalfa weevil and natural enemies disappear from the paddy fields in summer and this limits establishment. One parasitoid, *B. anurus*, however, was recovered in Fukuoka during 1997. Initially during establishment, the percentage parasitism was low but it increased gradually, reaching about 40% by 2003 (Shoubu *et al.* unpubl.). *B. anurus* is a univoltine, solitary, endoparasitoid of the alfalfa weevil larvae and its life cycle is well synchronized with its host in Kyushu (Okumura *et al.* 2002). Our survey showed that weevil damage on Chinese milk vetch was reduced from 2001 to 2003. Another survey reported higher parasitism by *B. anurus* on weevils in wild leguminosae (e.g., *M. hispida* and *V. sativa*) in surrounding grasslands than on weevils in Chinese milk vetch from paddy fields (Okumura 2002).

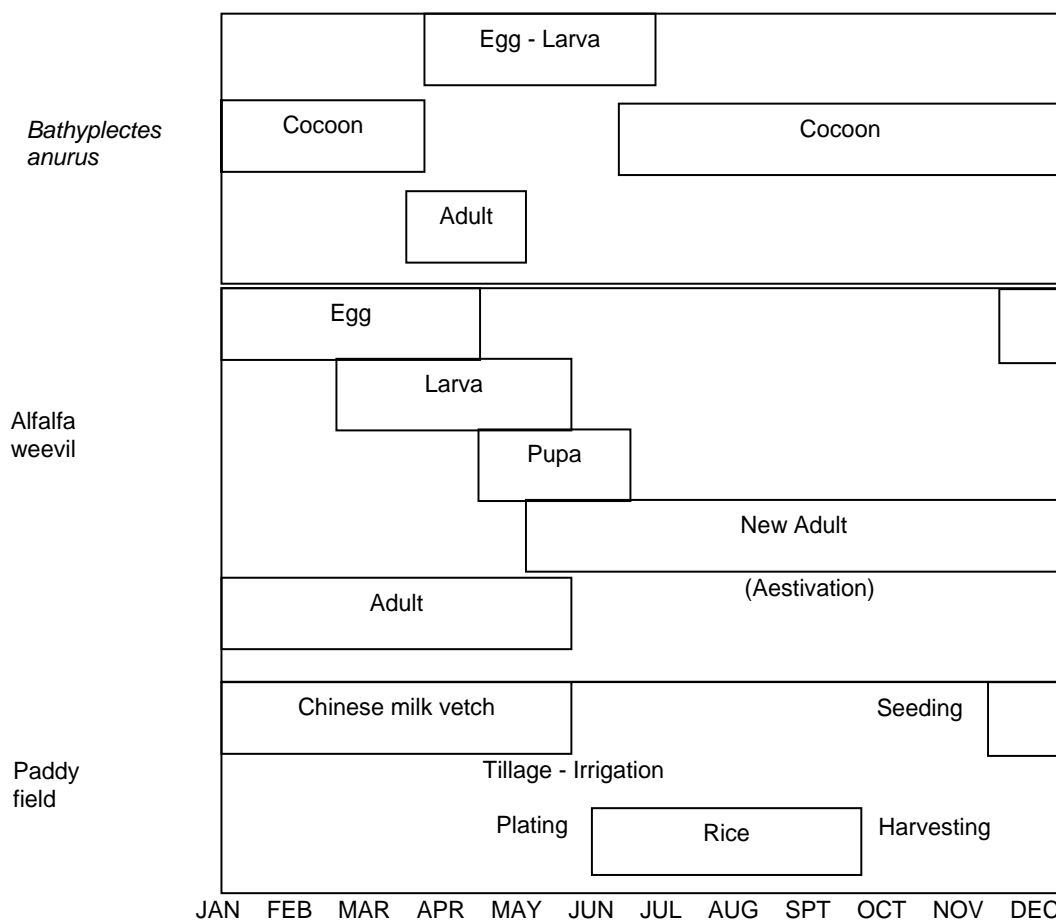


Figure 2. Life cycle of the alfalfa weevil, *Hypera postica* and its parasitoid, *Bathyplectes anurus* in a Japanese paddy field system.

DISCUSSION

Biological control of the alfalfa weevil has been of great economic benefit to U.S.A. alfalfa producers (Radcliffe *et al.* 1998). Shoubu *et al.* (2004) suggested that *B. anurus* was a promising agent for classical biological control of alfalfa weevil in Japan. Thus, a redistribution program for *B. anurus* is highly recommended for management of the alfalfa weevil in Japan. However, Japanese paddy agro-ecosystems are not very favourable for classical biological control because they are completely disrupted once a year during the late spring. Populations of *B. anurus* seem to be better maintained on wild leguminous plants in surrounding grasslands than on Chinese milk vetch in paddy fields. This suggests that conservation of grasslands surrounding paddy fields is very important if the effectiveness of *B. anurus* as a control agent for the alfalfa weevil is to be increased.

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